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(54) **CONCRETE SCREEDING MACHINE FOR TILT-UP PANELS**

BETONABZIEHMASCHINE FÜR HOCHKLAPPBARE PANELEE

MACHINE D'APLANISSEMENT DE BÉTON POUR PANNEAUX RELEVABLES

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(73) Proprietor: **Somero Enterprises, Inc. Ft. Myers FL 33912 (US)**

(72) Inventors:
• **HALONEN, Philip D. Calumet, Michigan 49913 (US)**

- **KANGAS, James E. Calumet, Michigan 49913 (US)**
- **KANGAS, Matthew A. Atlantic Mine, Michigan 49905 (US)**
- **PIETILA, Mark A. Atlantic Mine, Michigan 49905 (US)**

(74) Representative: **Taylor, Gail et al Kilburn & Strode LLP Lacon London 84 Theobalds Road London WC1X 8NL (GB)**

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Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims the filing benefits of U.S. provisional application Ser. No. 62/706,576, filed Aug. 26, 2020.

FIELD OF THE INVENTION

[0002] The present invention relates generally to an apparatus and method for screeding freshly poured concrete that has been placed over a support surface and, more particularly, to an apparatus and method for screeding concrete for a tilt-up panel.

BACKGROUND OF THE INVENTION

[0003] Screeding devices or machines are used to level and smooth uncured concrete to a desired grade. Known screeding machines typically include a screed head, which includes a vibrating member and a grade setting device, such as a plow and/or an auger device. Such screeding machines are used to smooth and screed concrete placed over a horizontal support surface, such as a floor of a building or structure. However, such conventional screeding machines are not suitable for screeding concrete placed for a tilt-up panel of a building. As shown in FIGS. 1-4, such tilt-up panels are formed or defined by forms or frames (such as wooden framework) that establish windows and perimeter edges of the concrete tilt-up panel.

US7311466B2 to Somero Enterprises, Inc. discloses a subgrade preparation apparatus for preparing a subgrade surface for concrete to be placed thereon, the apparatus comprising a base unit, an extendable boom, and a subgrade head assembly. US20030161684A1 to P.J. Quenzi discloses a subgrade preparation apparatus to level, grade, and compact a subgrade surface for receiving a preformed concrete slab on the subgrade, the apparatus comprising a base unit, an extendable boom, and a screed head assembly. US6129481A to Delaware Capital Formation, Inc. discloses a screeding assembly for spreading, grading, consolidating, and smoothing loose material such as uncured concrete, the assembly comprising a rotatable auger, a vibratory screed, and an elongated engaging member.

SUMMARY OF THE INVENTION

[0004] The present invention provides a screeding machine according to claim 1 that is operable to screed concrete that is disposed within forms or framework for forming a tilt-up concrete panel (or other concrete slabs or structure formed within and defined by form boards or framework) that, after the concrete is screeded and cured, is raised to a vertical orientation for use as part of a wall of a building. The screeding machine includes a

base unit and a screed head that is extendable and retractable relative to the base unit, such as via a multi-stage telescoping boom or other suitable extension/retraction mechanism, and that is raisable and lowerable relative to the end of the extension/retraction mechanism via elevation cylinders or actuators. The screeding machine includes a control system that operates in a float mode when the sensor control is turned off and the screed head is at and on a form or frame portion of the framework, allowing the screed to float or rest on said frame portion as the screed head is moved along to screed the concrete, and operates in a sensor control mode, responsive to the elevation sensor, when the screed head is not at a form or frame portion of the framework to maintain the screed head at the desired or appropriate or set grade, and is screeding the concrete responsive to signals from the sensors (e.g., laser receivers or other suitable sensors that are used to determine the position of the screed head) of the elevation cylinders. The elevation cylinders comprise reduced friction seals to allow for enhanced floating of the screed head when in the float mode and the elevation cylinders provide reduced downward creep of the screed head when the cylinders are not being actively pressurized to raise or lower the screed head. The screeding machine includes adjustable wings that are adjustably positioned at the grade establishing member and movable along the grade establishing member (via respective actuators) so the wings are positioned at the forms of the framework when the screed head is at the forms or frame portions to limit excess concrete from flowing along the grade establishing member and over the framework. The screeding machine also includes an active or dynamically adjustable counterweight that is automatically moved in a direction parallel to the axis of the boom responsive to the degree of extension of the boom and screed head.

[0005] These and other objects, advantages, purposes and features of the present invention are achieved by a machine according to claim 1 and the appended claims and will become apparent upon review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIGS. 1-4 are perspective views showing conventional tilt-up panels and the processes in forming the tilt-up panels;

FIG. 5 is a perspective view of a concrete leveling and screeding machine;

FIG. 6 is a perspective view and block diagram of the screed head of the screeding machine, with the plow wings adjusted to correspond with the window forms of the tilt-up panel framework;

FIGS. 7 and 8 are perspective views of the screed head, showing the plow wings at an outer end of the screed head (FIG. 7) and showing the plow wings

adjusted inward to adapt the screed head for the window forms (FIG. 8);

FIG. 9 is another perspective view of the concrete leveling and screeding machine, shown with the screed head and boom retracted, with the dynamic counterweight moved toward the boom;

FIG. 10 is another perspective view of the concrete leveling and screeding machine, shown with the screed head and boom extended, with the dynamic counterweight moved in a direction opposite the boom extension direction;

FIG. 11 is a side elevation of a screed head elevation cylinder of the screeding machine having a larger diameter upper rod or post and a smaller diameter lower rod or post;

FIG. 11A is a sectional view of the screed head elevation cylinder, taken along the line A-A in FIG. 11;

FIG. 12 is a side elevation of a screed head elevation cylinder of a screeding machine having a smaller diameter upper rod or post and a larger diameter lower rod or post;

FIG. 12A is a sectional view of the screed head elevation cylinder, taken along the line A-A in FIG. 12; and

FIG. 13 is a schematic diagram of a hydraulic float circuit for screed head elevation cylinders.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0007] Referring now to the drawings and the illustrative embodiments depicted therein, a concrete leveling and screeding machine 10 includes a base unit 12 with an extendable and retractable support or mechanism, such as a boom 14 extending from the base unit and supporting a screeding head or assembly 16 at an outer end thereof (FIG. 5). The base unit 12 is movable or drivable to a targeted area at a support surface with uncured concrete placed thereat, and the base unit may include an upper portion 12a that rotates or pivots about a base portion 12b to swing the boom and screeding head to a targeted location. The base portion 12b includes a plurality of wheels (e.g., four wheels) that are rotatably drivable and steerable to maneuver the base unit 12 to an appropriate screeding position relative to the concrete panel to be screeded.

[0008] When the machine is positioned at the screeding position (e.g., at a side region of the framework for forming a tilt-up concrete panel or other concrete slab or structure formed within and defined by form boards or framework), the boom 14 is extendable to move the screeding head 16 over the placed, uncured concrete to a starting position. The boom is then retracted to pull the screeding head toward the base unit, while the screeding head 16 operates to establish a desired grade of the concrete surface and smooth or finish or screed the concrete. In the illustrated embodiment, the screeding head includes a grade setting device 18 (such as a roller

plow or vibrating plow and/or auger) and a vibrating member 20. The screeding machine includes a plurality of stabilizers 22, which may be extendable and retractable relative to the base portion 12, to support and stabilize the machine on the support surface during the screeding operation. The controller of the screeding machine individually controls the elevation cylinders 26 of the screed head to raise and lower the screed head responsive to signals generated by sensors of the machine, such as, for example, responsive to signals generated by laser receivers 24, which sense a laser reference plane generated at the work site, or such as, for example, 3D target/sonic tracers or any suitable sensor or sensing system that operates to generate an output indicative of the grade or angle or location of the screed head at the concrete.

[0009] The screeding machine comprises a pressurized hydraulic fluid system powered by an engine at the base unit that drives the hydraulic system to generate pressurized fluid for controlling the elevation actuators or cylinders 26 and stabilizers 22 and for rotating the upper base portion 12a relative to the lower base portion 12b and for controlling the extension and retraction mechanism (such as the telescoping boom or articulating arm or any other suitable mechanism that operates to extend and retract while supporting the screed head) and for driving and steering of the wheels of the base unit. The screeding machine 10 and the screeding head or assembly 16 may utilize aspects of the screeding machines and screeding heads described in U.S. Pat. Nos. 4,655,633; 4,930,935; 6,227,761; 6,976,805; 7,044,681; 7,121,762; 7,175,363; 7,195,423; 7,396,186; 7,850,396; 8,038,366; 9,835,610; 10,190,268 and/or 10,895,045, and/or U.S. Publication Nos. US-2010-0196096 and/or US-2007-0116520.

[0010] The screeding machine 10 is suitable for use in screeding concrete placed within an area defined by forms or framework for forming tilt-up wall panels. Typically, such tilt-up panels are formed by arranging wooden forms or frames at a support surface that form or shape the perimeter of the panel and that form or shape windows or other openings that are to be present through the panel after the panel is formed, with such frames or forms comprising 2x10 or 2x12 (or other suitable size) wooden form boards or beams that are cut and supported on edge at the support surface to form or define the shape of the tilt-up panel and openings. In forming the tilt-up wall panels, operators will often screed the floor of a building first or create a slab to arrange the framework on and to pour the concrete for the panels on, and then the operators form the individual wall panels which are poured, cured and lifted in place with a crane. Such tilt-up panels are typically screeded by hand or small hand-controlled vibrator screeds (see FIGS. 1-4).

[0011] The screeding machine 10 is operable to screed the tilt up panels, thereby reducing the time to screed the tilt-up panels and reducing the number of laborers required to form the tilt-up panels. Because of the presence

of the side framework, the screeding machine cannot be driven into the panel area. Thus, the extension and retraction mechanism or boom 14 of the screeding machine 10 is extendable to move the screed head substantially out over the placed concrete to screed the concrete panels while they are flat or horizontal on the ground or support surface. In the illustrated embodiment, the boom comprises a four stage boom (having four telescoping sections 14a-d, as best shown in FIG. 10) and is extendable to move the screed head about 50 feet (1524 cm) from the base unit so that the screed head 16 can reach well into the panel area.

[0012] As the screed head 16 is moved toward the base portion 12 in the screeding direction via retraction of the boom 14, the vibrating member or floating vibrator 20 floats behind the grade establishing member or grade setting device or roller plow or vibrating plow 18. The grade establishing member may comprise any suitable plow or grader or member. For example, the grade establishing member may comprise a generally sharp edge or may comprise a rounded surface or chamfered edge or non-sharp edge (unlike a conventional or knife edge plow for a screed head) to avoid digging into the form board when the machine is operating in the float mode. Thus, the grade establishing member may comprise a rotating or spinning roller plow (rotatably driven via a hydraulically driven motor controlled by the controller of the machine) or a vibrating plow (e.g., a 2 inch (60,96 cm) or 4 inch (121,92 cm) wide vibrating plow that is vibrated or oscillated via a hydraulically driven motor), which provides a larger concrete engaging surface area, and which prevents the grade establishing member from digging into the form board due to the weight, and which may generate cream near the form board to leave an enhanced appearance of the finished concrete near the form board. Optionally, the vibrator 20 may include a flexible trailing edge or portion that can flex downward into the concrete transferring more vibration into the concrete. The flexible trailing edge may have fingers or ribs to allow for flexibility of the trailing edge portion while maintaining enough strength to transfer the vibration into the concrete. The screed head may comprise any suitable length grade establishing member and vibrator, such as, for example, an eight foot (1 foot=30,48 cm) grade establishing member and/or vibrator or the like.

[0013] The screed head 16 is pivotally mounted at the outer end of the boom 14 and can rotate about a vertical axis relative to the horizontally extending boom to allow for adjustment of the screed head as the screed head is moved over and along the concrete surface. In the illustrated embodiment, the screed head can rotate about 150 degrees about the vertical axis at the end of the boom.

[0014] The screeding machine 10 may comprise a remotely controlled machine (i.e., no operator station on the base of the machine), such that an operator can control the extension and retraction of the boom and the rotation of the screed head and the elevation of the

screed head and actuation of the roller plow and vibrator, etc., via a remote control device separate and remote from the machine. The remote control device may wirelessly communicate with a controller or control system of the machine via any suitable means, such as radio communication or other wireless communications.

[0015] The remote control may also include remote control of the base unit to drive and steer the wheels (such as four wheel steering, two wheel steering and/or crab steering or the like) of the base unit to position the machine at a screeding location. The stabilizers 22 may vertically extend and retract to support the machine at the desired screeding location, and may extend horizontally outward from the machine to provide a larger stabilization footprint for the machine. This is helpful due to the substantial distance the four-stage boom 14 can extend from the base unit 12.

[0016] In addition, the pivotable or rotatable upper portion 12a of the base unit 12 includes a dynamically adjustable or active counterweight 28 that moves in the opposite direction of the screed head 16 as the boom 14 extends/retracts. For example, and such as can be seen with reference to FIGS. 9 and 10, as the boom 14 extends and thus moves the screed head 16 away from the base unit 12 in one direction, the counterweight 28 moves in the opposite direction as the extension of the boom to balance the machine as the screed head moves further away from the base unit. The counterweight moves automatically responsive to extension/retraction of the boom and moves in a distance that is proportional to the distance that the boom extends.

[0017] The counterweight may move responsive to a position sensor or linear movement sensor (that senses extension/retraction of the boom) or responsive to a moment or torque sensor (that senses the torque at the base unit caused by the extension of the boom) or any suitable sensing means (that generates a signal or output that is representative of the degree of extension of the boom and/or position of the screed head relative to the base unit), such that the counterweight is automatically moved an appropriate amount as the boom 14 extends and retracts to move the screed head 16. Thus, the machine provides a large counterweight 28 that moves outward from the base unit 12 (away from the screed head) when the boom and screed head are extended out for better balance and that moves inward toward the base unit 12 (toward the screed head) when the boom and screed head are retracted so the machine does not get rear heavy.

[0018] As shown in FIGS. 6-8, the screed head 16 includes adjustable plow wings 30 that are adjustably positioned at the grade establishing member or plow (e.g., the roller plow or vibratable plow or other suitable grade establishing member or device) and that are adjustable along the grade establishing member. The plow wings 30 function to limit excess concrete that is pushed by the grade establishing member from flowing around the ends of the grade establishing member 18, in order to

avoid the excess concrete from flowing onto an already screeded portion of the panel. The plow wings 30 are adjustable along the grade establishing member 18 to limit the excess concrete at different locations and/or widths along the grade establishing member. As can be seen with reference to FIGS. 7 and 8, the plow wings may be positioned at outer opposite ends of the grade establishing member (FIG. 7) and may be adjustable or movable inward toward one another (either individually movable or movable in tandem) to contain the excess concrete ahead of the grade establishing member within a smaller or reduced portion (see FIG. 8) of the overall length of the grade establishing member 18.

[0019] In the illustrated embodiment, each plow wing 30 is independently movable along the grade establishing member 18 via a respective actuator 32 that extends to move the plow wing toward the outer end of the grade establishing member and retracts to draw or move the plow wing toward the center of the grade establishing member. The plow wings 30 may be slidably disposed at the grade establishing member and may slide along the forward surface of the grade establishing member 18 (the surface facing the boom and base unit), such as via sliding elements and tracks that allow for horizontal movement of the plow wings along the grade establishing member in the direction along or across the grade establishing member, while limiting or precluding movement of the plow wings vertically with respect to the grade establishing member and while limiting or precluding rotation or pivoting of the plow wings relative to the grade establishing member.

[0020] Thus, the plow wings 30 are adjustable so that the operator can adjust the effective width of the grade establishing member and screed head while screeding the concrete of the tilt-up panel. For example, when the screeding machine and screed head is screeding the concrete where there are no window forms present, the plow wings can be moved toward and to the ends of the grade establishing member to provide an effective width of the screed head 16 corresponding substantially to the width of the grade establishing member 18. When one or both ends of the grade establishing member 18 and screed head is/are resting on a form (such as the forms or frames that form or establish windows through the formed tilt-up panel), the plow wing or wings can be moved inward so that the plow wings are positioned at the respective wooden form or frame portion (see FIG. 6) to limit or preclude excess concrete from flowing over the forms or frames and into the window space (and onto the already screeded and cured floor or support surface at which the tilt-up panel is being formed).

[0021] The actuators 32 may be independently and/or jointly operated by the operator (such as by using the remote controller for the machine) to position each wing 30 at the appropriate location along the grade establishing member 18. Optionally, the actuators 32 may automatically operate to move the plow wings 30 to be positioned at a frame or form, such as responsive to deter-

mination of the presence of a frame or form at or near the screed head 18, such as via a map input of the layout of the tilt-up panel and forms or such as responsive to a sensor that senses presence (or lack of presence) of a frame or form as the screed head 16 moves along and over the poured concrete. Thus, as the screed head 16 is moved over and along the concrete surface where no window frames are present, the operator and/or controller, via the actuator 32, may move the plow wings 30 to the respective ends of the grade establishing member 18, and as the screed head 16 is moved to the location where one or both ends of the grade establishing member and screed head are positioned over a respective window frame or form (or other frame or form for use in forming the tilt-up panel), the actuator may move the respective wing or wings inward to position them at and on top of the respective frame or form. After the screed head 16 has moved past the window frame or form, the actuator 32 may move the wing or wings 30 back toward or to the respective end of the grade establishing member 18 as the screed head continues screeding the concrete panel.

[0022] Because the screed head 16 may be moved from locations where the forms or framework are present to locations where no forms or framework is present, the operation of the screeding machine may be adjusted to adapt for the changes in the type of screeding that is desired for the different locations. The screeding machine 10 thus may adjust the operating mode when the screed head is moved from screeding concrete at a location where there are no frames or forms present to a location where a frame or form is at one or both of the ends of the screed head. For example, when the screed head 16 is screeding concrete where no forms are present, the system may operate in a sensor control mode, where the screed head is raised and lowered responsive to signals from the grade sensors 24 (e.g., laser receivers) to maintain the screed head 16 at the desired or appropriate or set grade. When the screed head 16 is moved to a location where forms or frames are present, the machine can switch to a float mode where the sensor control is turned off and the screed is allowed to float or rest on the forms or frames as the screed head is moved along to screed the concrete.

[0023] Each end of the screed head 16 may independently switch between sensor control mode and float mode so that one end of the screed head may be controlled responsive to the respective sensor 24, while the other end of the screed head may float or rest on the frame or form. Thus, the operator can select to have one end of the screed head float on the frame (and can adjust the plow wing to be positioned at the frame) and have the other end of the screed head be under sensor control (and can adjust the plow wing to be positioned at that end of the grade establishing member).

[0024] The screeding machine may also automatically switch between the float mode and the sensor control mode based on the location of the screed head relative to the forms or frames. For example, the screeding machine

may automatically switch to the sensor control mode if the screed head 16 drops a threshold amount, such as when the screed head moves (while in float mode) along and off of a form or frame, in order to correct when an operator may forget to switch the system to the sensor control mode at the end of the window form. Optionally, the system and machine may automatically switch between the float mode and the sensor control mode responsive to detection (such as via any suitable sensor, such as an imaging sensor or a concrete sensor or hardness sensor or the like) of presence (or lack of presence) of a form at and below the screed head 16 as the screed head moves over and along the poured concrete.

[0025] The elevation actuators or cylinders 26 thus may be selectively pressurized responsive to signals from the sensors (e.g., laser receivers) when the screeding machine is operating in the sensor control mode, and may be de-pressurized (via stopping supply of pressurized fluid and opening the cylinder ports to the zero pressure reservoir circuit) so that the cylinder allows for adjustment in either direction (up or down) of the respective end of the screed head as the screed head is positioned at and allowed to rest on and move along the respective frame. As shown in FIGS. 11 and 11A, the elevation cylinder includes a central cylinder 26a having a center piston element 26b that connects at one end to a smaller diameter lower rod or post 26c and at the other end to a larger diameter upper rod or post 26d. The screed head is attached at the lower end of the smaller diameter rod 26c, while the laser receiver is attached at the upper end of the larger diameter rod 26d. The center piston element 26b has low friction sealing rings, such as cast iron rings for reduced friction at the inner wall surface of the central cylinder 26a as the piston element (and the laser receiver and the end of the screed head) moves relative to the central cylinder 26a (such as when one of the chambers above or below the piston and defined by the inner wall surface of the cylinder and the respective rod is pressurized). The seals at the ends of the cylinder also comprise low friction "unloaded" gland seals to reduce friction at the respective rod as the rods are moved relative to the cylinder.

[0026] By providing different diameter upper and lower rods (and thus different volume chambers of the central cylinder above and below the piston element), lower friction cast iron sealing rings can be used, even though such rings may allow for fluid leakage between the chambers in the central cylinder. The cast iron piston rings provide for low friction performance when the system is operating in the float mode, but since they will leak oil past the rings, a dual rod cylinder with equal diameter rods would creep downward as the machine sits unused (even if the cylinder ports are capped) due to the weight of the screed head pulling on the lower rod. Providing upper and lower rods having different diameters precludes the rods from creeping downward when the position of the screed head is locked, such as when sitting unused.

[0027] The upper rod 26d has a larger diameter than

the lower rod 26c so as to provide a chamber having a smaller volume of hydraulic oil or fluid above the piston than the larger volume of oil (due to the smaller diameter lower rod) below the piston. Thus, when both chambers contain oil, such as when the vertical position of the screed head is locked, the load of the screed head attached at the lower end of the smaller diameter rod 26c pulls the rod downward. This downward force thus tries to force oil from the larger volume lower chamber into the smaller volume upper chamber. However, in order for the oil to be pushed from the larger volume chamber into the smaller volume chamber, the oil would have to be compressed. The weight of the screed head is not significant enough to cause compression or noticeable creep. Thus, the larger diameter upper rod 26d (and therefore smaller upper chamber) and smaller diameter lower rod 26c (and therefore larger lower chamber) resist the creep phenomenon due to the inherent incompressible nature of the hydraulic oil or fluid filling the chambers.

[0028] Optionally, and as shown in FIGS. 12 and 12A, the elevation actuator 126 includes a central cylinder 126a that receives an upper rod 126d having a smaller diameter than the lower rod 126c in order to create a larger oil volume in the chamber above the piston 126b than in the chamber below the piston. Therefore, as gravity tries to pull the lower rod 126c downward, the lower chamber needs to displace a smaller volume of oil over to the upper chamber which is a larger volume chamber. This creates a vacuum in the upper chamber that resists the creep phenomenon. In the opposite direction, a larger volume of fluid cannot be forced into the smaller volume chamber.

[0029] Thus, when the system operates in the float mode, the pressurized fluid is not provided to either chamber and the ports are closed to pressurized fluid and opened to the zero pressure reservoir circuit so that the piston element and the rods move relative to the cylinder, with the lower friction rings and seals allowing for low friction movement of the rods (and the screed head) relative to the cylinder. In other words, pressurized fluid is not provided to the float circuit so that the screed head may rest or float on the forms. When operating in the sensor control mode, pressurized fluid is provided at one chamber (to raise or lower the sensor or laser receiver and respective screed head end) and the different volume chambers function to hold the rods at a set location relative to the cylinder when additional hydraulic fluid is not being provided to either chamber. The elevation cylinders thus provide for a reduced friction float mode while also providing sensor control of the actuators and a locking or non-creeping function.

[0030] Optionally, when in the float mode, the elevation actuators may be at least partially pressurized, so as to ensure that the bottom of the screed head remains in contact with the top of the form. This may be achieved by providing a minimal level of pressure in the upper cham-

ber or a minimal pressure difference between the upper chamber and the lower chamber. Thus, pressure may be maintained in the upper chamber to provide a minimal or threshold level of downward force. This can be achieved via a check valve in the float circuits. For example, FIG. 13 depicts a schematic diagram of a hydraulic float circuit 100 showing the flow of pressurized fluid for operating the hydraulic elevation actuators 226, each including a hydraulic cylinder 226a having a piston element 226b, a lower rod 226c in a lower chamber, and an upper rod 226d in an upper chamber. The hydraulic lines to the solenoids that control pressurization of the respective cylinder chamber or portion are in fluid communication with a hydraulic pump or pressurized fluid source, while the hydraulic lines to the solenoids that allow flow of fluid from the respective cylinder chamber or portion (when the other cylinder chamber or portion is pressurized) are in fluid communication with a fluid reservoir (which is in fluid communication with the hydraulic pump).

[0031] As shown in FIG. 13, the pressurized fluid flows to and from the lower chamber and the upper chamber, where a check valve 34 is disposed in each of the flow paths of the lower chamber and the upper chamber. The check valve 34 includes a spring that provides a given amount of backpressure, thus providing the minimal levels of pressure in the chambers, such as at least a set amount of pressure in the circuit for the upper chamber. For example, with a check valve with a 15 psi spring in the float circuit, the upper chamber may always have at least 15 psi of pressure so long as the float circuit is supplied with oil via a control valve of the circuit and the valve is opened.

[0032] Thus, the system may switch between the float mode and the sensor control mode on the fly. When one side of the screed head is resting on the form board, the operator can flip the sensor control off (to depressurize the elevation cylinder) for that end or side or actuator and let that end or side of the screed head float down to ride on the form board, while the other actuator continues to operate in the sensor control mode. If, when operating in the float mode, the form board is too low or if the screed head drops too far (e.g., up to or more than 1/8 inch (3,81 cm) or 1/4 inch (7,62 cm) or 3/4 inch (22,86 cm)) the system can automatically switch that actuator (or both actuators) back to the sensor control mode. Thus, if the operator is slow to switch back to sensor control when the screed head gets to the end of the window form and the head starts to sink in the concrete, the system automatically switches back to sensor control mode to avoid further sinking of the screed head at the concrete.

[0033] Therefore, the system or machine or method for screeding uncured concrete for a tilt-up panel includes a screeding machine comprising a screed head assembly, a pair of elevation sensors disposed at opposite ends of the screed head assembly, and a control. The screed head assembly is moved over the concrete surface via the screeding machine to screed the concrete surface. The elevation sensors or laser receivers sense an eleva-

tion of the respective end of the screed head assembly relative to a laser-generated reference plane established above the tilt-up panel, and the elevation cylinders operate to adjust the height of the screed head responsive to the laser signal received by the laser receivers to screed the concrete of the tilt-up panel at the appropriate grade. Although shown and described as having the elevation actuators or cylinders disposed at and attached at the ends of the screed head, the screeding machine may include other types of elevation actuators, such as actuators or cylinders disposed at the extendable and retractable mechanism or boom or disposed at the base unit or the like. The screeding machine may operate in a float mode when the screed head is positioned at the frame or form, and may operate in a sensor control mode when the screed head is screeding concrete at locations where the frame or form is not present. The elevation cylinders comprise low friction seals to allow for floating of the screed head at the forms, and the elevation cylinders limit creep due to gravity. The screed head includes adjustable plow wings that are moved along the grade establishing member of the screed head to be positioned over the frame or form of the tilt-up panel.

[0034] Changes and modifications to the specifically described embodiments can be carried out without departing from the principles of the present invention, which is intended to be limited only by the scope of the appended claims as interpreted according to the principles of patent law.

Claims

1. A screeding machine (10) for screeding uncured concrete placed within framework to form a concrete structure, the screeding machine (10) comprising:

a base unit (12) positionable at framework that defines the concrete structure to be formed;
 a screed head assembly (16) movably mounted at the base unit (12) via an extendable and retractable mechanism (14), wherein the screed head assembly (16) comprises (i) a grade establishing member (18), (ii) a vibrating member (20), and (iii) adjustable wings (30) disposed at and in front of the grade establishing member (18) in a screeding direction, and wherein the adjustable wings (30) are movable along the grade establishing member (18) via respective actuators (32);
 elevation actuators (26) operable to adjust elevation of the screed head assembly (16) responsive at least in part to elevation sensors (24) that sense elevation of respective ends of the screed head assembly (16);
 a control system, wherein the control system, responsive to signals from the elevation sensors (24), controls the elevation actuators (26) to set

the grade of the uncured concrete;
 wherein the screed head assembly (16) is positionable at a screeding location within the framework via extension of the extendable and retractable mechanism (14) and is movable over the uncured concrete in the screeding direction from the screeding location via retraction of the extendable and retractable mechanism (14);
 wherein, when one of the ends of the screed head assembly (16) is positioned at a frame portion that defines part of the concrete structure being formed, the wing (30) at that end of the screed head assembly (16) is moved via actuation of the respective actuator (32) to position the wing (30) at the frame portion to limit excess concrete in front of the grade establishing member (18) in the screeding direction from flowing over the frame portion when the screed head assembly (16) is moved in the screeding direction; and

characterized in that the control system operates in a float mode when the sensor control is turned off and the screed head assembly (16) is positioned at the frame portion allowing the screed to float or rest on said frame portion as the screed head (16) is moved along to screed the concrete, and operates in a sensor control mode, responsive to the elevation sensor (24), when the screed head assembly (16) is positioned at a location where no frame portion is present to maintain the screed head (16) at the desired or appropriate or set grade.

2. The screeding machine (10) of claim 1, wherein the screeding machine (10) comprises a wheeled unit.
3. The screeding machine (10) of claim 1, wherein the elevation sensors (24) comprise laser receivers disposed at respective elevation actuators (26) disposed at the screed head assembly (16) for sensing an elevation of the respective end of the screed head assembly (16) relative to a laser generated reference plane established at the framework.
4. The screeding machine (10) of claim 1, wherein the actuators (32) of the wings (30) are actuated via a user actuatable input.
5. The screeding machine (10) of claim 1, wherein the actuators (32) of the wings (30) are actuated responsive to the control system determining presence of the frame portion at the screed head assembly (16).
6. The screeding machine (10) of claim 5, wherein the control system determines presence of the frame portion via a sensor that generates an output indicative of presence of the frame portion at the screed head assembly (16).
7. The screeding machine (10) of claim 5, wherein the control system determines presence of the frame portion via a map input indicative of presence of the frame portion at the screed head assembly (16).
8. The screeding machine (10) of claim 1, wherein the control system automatically switches from the float mode to the sensor control mode responsive to a drop of the screed head assembly (16) by a threshold amount.
9. The screeding machine (10) of claim 1, wherein the elevation actuators (26) are disposed at the screed head assembly (16), and wherein each elevation actuator (26) comprises (i) a double ended hydraulic cylinder (226a) having a lower rod (226c) having a first diameter and an upper rod (226d) having a second diameter different from the first diameter and (ii) a piston element (226b) disposed within the hydraulic cylinder (226a), and wherein the lower rod (226c) extends from the piston element (226b) through a lower chamber of the hydraulic cylinder (226a) and the upper rod (226d) extends from the piston element (226b) through an upper chamber of the hydraulic cylinder (226a).
10. The screeding machine (10) of claim 9, wherein the first diameter is smaller than the second diameter.
11. The screeding machine (10) of claim 9, wherein the first diameter is larger than the second diameter.
12. The screeding machine (10) of claim 9, wherein, when operating in the float mode, the lower chamber and the upper chamber are not pressurized to allow the screed head assembly (16) to move upward and downward relative to the hydraulic cylinder (226a).
13. The screeding machine (10) of claim 9, wherein, when operating in the float mode, at least one of the lower chamber and the upper chamber is at least partially pressurized to maintain a threshold level of pressure in the upper chamber.
14. The screeding machine (10) of claim 9, wherein, when operating in the sensor control mode, the lower chamber and the upper chamber cooperate to limit downward creep of the screed head assembly (16).
15. The screeding machine (10) of claim 1, wherein the base unit (12) comprises an adjustable counterweight (28), and wherein the adjustable counterweight (28), when the screed head assembly (16) is moved via extension or retraction of the extendable and retractable mechanism (14), is automatically moved in a direction opposite of movement of the screed head assembly (16) to counter the weight of the screed head assembly (16) when extended

and retracted via the extendable and retractable mechanism (14).

16. The screeding machine (10) of claim 15, wherein the adjustable counterweight (28) is moved in the direction opposite of movement of the screed head assembly (16) an amount proportional to the extension or retraction of the extendable and retractable mechanism (14). 5
17. The screeding machine (10) of claim 1, wherein the control system is operable responsive to a remote controller usable by an operator remote from the screeding machine (10). 10
18. The screeding machine (10) of claim 1, wherein the grade establishing member (18) comprises one selected from the group consisting of (i) a roller plow and (ii) a vibrating plow. 15
19. The screeding machine (10) of claim 1, wherein the screeding machine (10) screeds uncured concrete placed within framework to form a tilt-up panel. 20

Patentansprüche

1. Betonabziehmaschine (10) zum Abziehen von nicht ausgehärtetem Beton, der innerhalb einer Schalung eingebracht ist, um eine Betonstruktur zu formen, wobei die Betonabziehmaschine (10) Folgendes umfasst: 25

eine Basiseinheit (12), die an einer Schalung positionierbar ist, die die zu formende Betonstruktur definiert; 30

eine Abziehkopfanordnung (16), die über einen ausfahrbaren und einfahrbaren Mechanismus (14) beweglich an der Basiseinheit (12) montiert ist, wobei die Abziehkopfanordnung (16) (i) ein Nivellierelement (18), (ii) ein Vibrationselement (20) und (iii) verstellbare Flügel (30) umfasst, die am und vor dem Nivellierelement (18) in einer Abziehrichtung angeordnet sind, und wobei die verstellbaren Flügel (30) über jeweilige Aktuatoren (32) entlang des Nivellierelements (18) bewegbar sind; 35

Höhenaktuatoren (26), die zum Anpassen der Höhe der Abziehkopfanordnung (16) zumindest teilweise in Reaktion auf Höhenfühler (24) betrieben werden, die die Höhe der jeweiligen Enden der Abziehkopfanordnung (16) erfassen; 40

ein Steuersystem, wobei das Steuersystem in Reaktion auf Signale der Höhenfühler (24) die Höhenaktuatoren (26) steuert, um das Gefälle des nicht ausgehärteten Betons einzustellen; 45

wobei die Abziehkopfanordnung (16) über das Ausfahren des ausfahrbaren und einfahrbaren 50

Mechanismus (14) an einer Abziehposition innerhalb der Schalung positionierbar ist und über das Einfahren des ausfahrbaren und einfahrbaren Mechanismus (14) in der Abziehrichtung über den nicht ausgehärteten Beton von der Abziehposition bewegbar ist;

wobei, wenn eines der Enden der Abziehkopfanordnung (16) an einem Rahmenteil positioniert ist, das einen Teil der zu formenden Betonstruktur definiert, der Flügel (30) an diesem Ende der Abziehkopfanordnung (16) durch Betätigung des jeweiligen Aktuators (32) bewegt wird, um den Flügel (30) an dem Rahmenteil zu positionieren, um zu verhindern, dass überschüssiger Beton vor dem Nivellierelement (18) in der Abziehrichtung über das Rahmenteil fließt, wenn die Abziehkopfanordnung (16) in der Abziehrichtung bewegt wird; und

dadurch gekennzeichnet, dass das Steuersystem im Float-Modus arbeitet, wenn die Sensorsteuerung ausgeschaltet ist und die Abziehkopfanordnung (16) am Rahmenteil positioniert ist, sodass der Abziehkopf auf dem Rahmenteil schwimmen oder ruhen kann, während der Abziehkopf (16) entlanggeführt wird, um den Beton abzuziehen, und im Sensorsteuerungsmodus, in Reaktion auf den Höhenfühler (24), arbeitet, wenn die Abziehkopfanordnung (16) an einer Position positioniert ist, an der kein Rahmenteil vorhanden ist, um den Abziehkopf (16) auf dem gewünschten oder geeigneten oder eingestellten Gefälle zu halten. 25

2. Betonabziehmaschine (10) nach Anspruch 1, wobei die Betonabziehmaschine (10) eine mit Rädern versehene Einheit umfasst. 30

3. Betonabziehmaschine (10) nach Anspruch 1, wobei die Höhenfühler (24) Laserempfänger umfassen, die an jeweiligen Höhenaktuatoren (26) angeordnet sind, die an der Abziehkopfanordnung (16) angeordnet sind, um eine Höhe des jeweiligen Endes der Abziehkopfanordnung (16) relativ zu einer an der Schalung festgelegten lasergenerierten Referenzebene zu erfassen. 35

4. Betonabziehmaschine (10) nach Anspruch 1, wobei die Aktuatoren (32) der Flügel (30) über eine durch den Benutzer betätigbare Eingabe betätigt werden. 40

5. Betonabziehmaschine (10) nach Anspruch 1, wobei die Aktuatoren (32) der Flügel (30) in Reaktion auf die Feststellung des Steuersystems, dass sich das Rahmenteil an der Abziehkopfanordnung (16) befindet, betätigt werden. 45

6. Betonabziehmaschine (10) nach Anspruch 5, wobei das Steuersystem das Vorhandensein des Rahmen- 50

- teils über einen Sensor feststellt, der ein Ausgangssignal erzeugt, das das Vorhandensein des Rahmenteils an der Abziehkopfanordnung (16) anzeigt.
7. Betonabziehmaschine (10) nach Anspruch 5, wobei das Steuersystem das Vorhandensein des Rahmenteils über eine Karteneingabe feststellt, die das Vorhandensein des Rahmenteils an der Abziehkopfanordnung (16) anzeigt. 5
8. Betonabziehmaschine (10) nach Anspruch 1, wobei das Steuersystem automatisch vom Float-Modus in den Sensorsteuerungsmodus umschaltet, wenn die Abziehkopfanordnung (16) um einen Schwellwert abgesenkt wird. 10
9. Betonabziehmaschine (10) nach Anspruch 1, wobei die Höhenaktuatoren (26) an der Abziehkopfanordnung (16) angeordnet sind, und wobei jeder Höhenaktuator (26) (i) einen doppelseitigen Hydraulikzylinder (226a) mit einer unteren Stange (226c) mit einem ersten Durchmesser und einer oberen Stange (226d) mit einem zweiten Durchmesser, der sich vom ersten Durchmesser unterscheidet, und (ii) ein Kolbenelement (226b) umfasst, das innerhalb des Hydraulikzylinders (226a) angeordnet ist, und wobei sich die untere Stange (226c) vom Kolbenelement (226b) durch eine untere Kammer des Hydraulikzylinders (226a) und sich die obere Stange (226d) vom Kolbenelement (226b) durch eine obere Kammer des Hydraulikzylinders (226a) erstreckt. 20
10. Betonabziehmaschine (10) nach Anspruch 9, wobei der erste Durchmesser kleiner als der zweite Durchmesser ist. 25
11. Betonabziehmaschine (10) nach Anspruch 9, wobei der erste Durchmesser größer als der zweite Durchmesser ist. 30
12. Betonabziehmaschine (10) nach Anspruch 9, wobei im Float-Modus die untere Kammer und die obere Kammer nicht unter Druck stehen, um der Abziehkopfanordnung (16) eine Aufwärts- und Abwärtsbewegung relativ zum Hydraulikzylinder (226a) zu ermöglichen. 35
13. Betonabziehmaschine (10) nach Anspruch 9, wobei im Float-Modus mindestens eine der unteren Kammer und der oberen Kammer zumindest teilweise unter Druck steht, um einen Schwellwert des Drucks in der oberen Kammer aufrechtzuerhalten. 40
14. Betonabziehmaschine (10) nach Anspruch 9, wobei im Sensorsteuerungsmodus die untere Kammer und die obere Kammer zusammenwirken, um ein Absinken der Abziehkopfanordnung (16) nach unten zu begrenzen. 45
15. Betonabziehmaschine (10) nach Anspruch 1, wobei die Basiseinheit (12) ein verstellbares Gegengewicht (28) umfasst und wobei das verstellbare Gegengewicht (28), wenn die Abziehkopfanordnung (16) durch Ausfahren oder Einfahren des ausfahrbaren und einfahrbaren Mechanismus (14) bewegt wird, automatisch in eine der Bewegung der Abziehkopfanordnung (16) entgegengesetzte Richtung bewegt wird, um das Gewicht der Abziehkopfanordnung (16) beim Ausfahren und Einfahren durch den ausfahrbaren und einfahrbaren Mechanismus (14) auszugleichen. 50
16. Betonabziehmaschine (10) nach Anspruch 15, wobei das verstellbare Gegengewicht (28) in der der Bewegung der Abziehkopfanordnung (16) entgegengesetzten Richtung um einen Betrag proportional zum Ausfahren oder Einfahren des ausfahrbaren und einfahrbaren Mechanismus (14) bewegt wird. 55
17. Betonabziehmaschine (10) nach Anspruch 1, wobei das Steuersystem in Reaktion auf eine durch einen Bediener fern von der Betonabziehmaschine (10) verwendbare Fernsteuervorrichtung betreibbar ist.
18. Betonabziehmaschine (10) nach Anspruch 1, wobei das Nivellierelement (18) eines aus der Gruppe bestehend aus (i) einem Walzenpflug und (ii) einem Vibrationspflug umfasst.
19. Betonabziehmaschine (10) nach Anspruch 1, wobei die Betonabziehmaschine (10) nicht ausgehärteten Beton abzieht, der innerhalb einer Schalung eingebracht ist, um ein hochklappbares Paneel zu formen.

Revendications

1. Machine d'aplanissement (10) pour aplanir du béton non durci placé à l'intérieur d'une charpente pour former une structure de béton, la machine d'aplanissement (10) comprenant :
- une unité de base (12) pouvant être positionnée sur une charpente qui définit la structure de béton à former ;
- un ensemble tête d'aplanissement (16) monté mobile sur l'unité de base (12) par le biais d'un mécanisme extensible et rétractable (14), dans laquelle l'ensemble tête d'aplanissement (16) comprend (i) un organe d'établissement de niveau (18), (ii) un organe vibrant (20), et (iii) des ailettes réglables (30) disposées sur et devant l'organe d'établissement de niveau (18) dans une direction d'aplanissement, et dans laquelle les ailettes réglables (30) sont mobiles le long de l'organe d'établissement de niveau (18) par le biais d'actionneurs respectifs (32) ;

des actionneurs d'élévation (26) pouvant fonctionner pour régler l'élévation de l'ensemble tête d'aplanissement (16) en réponse au moins en partie à des capteurs d'élévation (24) qui détectent l'élévation d'extrémités respectives de l'ensemble tête d'aplanissement (16) ;

un système de commande, dans laquelle le système de commande, en réponse à des signaux provenant des capteurs d'élévation (24), commande les actionneurs d'élévation (26) pour définir le niveau du béton non durci ;

dans laquelle l'ensemble tête d'aplanissement (16) peut être positionné à un emplacement d'aplanissement à l'intérieur de la charpente par l'extension du mécanisme extensible et rétractable (14) et est mobile par-dessus le béton non durci dans la direction d'aplanissement depuis l'emplacement d'aplanissement par la rétraction du mécanisme extensible et rétractable (14) ;

dans laquelle, lorsque l'une des extrémités de l'ensemble tête d'aplanissement (16) est positionnée au niveau d'une partie de cadre qui définit une partie de la structure de béton en formation, l'ailette (30) à cette extrémité de l'ensemble tête d'aplanissement (16) est déplacée par l'actionnement de l'actionneur respectif (32) pour positionner l'ailette (30) au niveau de la partie de cadre pour limiter le béton en excès devant l'organe d'établissement de niveau (18) dans la direction d'aplanissement depuis l'écoulement sur la partie de cadre lorsque l'ensemble tête d'aplanissement (16) est déplacé dans la direction d'aplanissement ; et

caractérisée en ce que le système de commande fonctionne dans un mode flottant lorsque la commande de capteur est mise hors tension et l'ensemble tête d'aplanissement (16) est positionné au niveau de la partie de cadre permettant au guide d'aplanissement de flotter ou de reposer sur ladite partie de cadre lorsque la tête d'aplanissement (16) est déplacée pour aplanir le béton, et fonctionne dans un mode de commande de capteur, en réponse au capteur d'élévation (24), lorsque l'ensemble tête d'aplanissement (16) est positionné à un emplacement où aucune partie de cadre n'est présente pour maintenir la tête d'aplanissement (16) au niveau souhaité ou approprié ou défini.

2. Machine d'aplanissement (10) selon la revendication 1, dans laquelle la machine d'aplanissement (10) comprend une unité à roues.
3. Machine d'aplanissement (10) selon la revendication 1, dans laquelle les capteurs d'élévation (24) comprennent des récepteurs laser disposés sur des actionneurs d'élévation respectifs (26) disposés sur

l'ensemble tête d'aplanissement (16) pour détecter une élévation de l'extrémité respective de l'ensemble tête d'aplanissement (16) par rapport à un plan de référence généré par laser établi sur la charpente.

4. Machine d'aplanissement (10) selon la revendication 1, dans laquelle les actionneurs (32) des ailettes (30) sont actionnés par le biais d'une entrée pouvant être actionnée par un utilisateur.
5. Machine d'aplanissement (10) selon la revendication 1, dans laquelle les actionneurs (32) des ailettes (30) sont actionnés en réponse à la détermination par le système de commande de la présence de la partie de cadre au niveau de l'ensemble tête d'aplanissement (16).
6. Machine d'aplanissement (10) selon la revendication 5, dans laquelle le système de commande détermine la présence de la partie de cadre par le biais d'un capteur qui génère une sortie indiquant la présence de la partie de cadre sur l'ensemble tête d'aplanissement (16).
7. Machine d'aplanissement (10) selon la revendication 5, dans laquelle le système de commande détermine la présence de la partie de cadre par le biais d'une entrée de carte indiquant la présence de la partie de cadre sur l'ensemble tête d'aplanissement (16).
8. Machine d'aplanissement (10) selon la revendication 1, dans laquelle le système de commande commute automatiquement du mode flottant au mode de commande de capteur en réponse à un abaissement de l'ensemble tête d'aplanissement (16) d'une quantité seuil.
9. Machine d'aplanissement (10) selon la revendication 1, dans laquelle les actionneurs d'élévation (26) sont disposés sur l'ensemble tête d'aplanissement (16), et dans laquelle chaque actionneur d'élévation (26) comprend (i) un vérin hydraulique à double extrémité (226a) ayant une tige inférieure (226c) présentant un premier diamètre et une tige supérieure (226d) présentant un second diamètre différent du premier diamètre et (ii) un élément piston (226b) disposé à l'intérieur du vérin hydraulique (226a), et dans laquelle la tige inférieure (226c) s'étend depuis l'élément piston (226b) à travers une chambre inférieure du vérin hydraulique (226a) et la tige supérieure (226d) s'étend depuis l'élément piston (226b) à travers une chambre supérieure du vérin hydraulique (226a).
10. Machine d'aplanissement (10) selon la revendication 9, dans laquelle le premier diamètre est inférieur

au second diamètre.

11. Machine d'aplanissement (10) selon la revendication 9, dans laquelle le premier diamètre est supérieur au second diamètre. 5
12. Machine d'aplanissement (10) selon la revendication 9, dans laquelle pendant le fonctionnement en mode flottant, la chambre inférieure et la chambre supérieure ne sont pas sous pression pour permettre à l'ensemble tête d'aplanissement (16) de se déplacer vers le haut et vers le bas par rapport au vérin hydraulique (226a). 10
13. Machine d'aplanissement (10) selon la revendication 9, dans laquelle pendant le fonctionnement en mode flottant, au moins l'une de la chambre inférieure et de la chambre supérieure est au moins en partie sous pression pour maintenir un niveau seuil de pression dans la chambre supérieure. 15 20
14. Machine d'aplanissement (10) selon la revendication 9, dans laquelle pendant le fonctionnement en mode de commande de capteur, la chambre inférieure et la chambre supérieure coopèrent pour limiter le glissement vers le bas de l'ensemble tête d'aplanissement (16). 25
15. Machine d'aplanissement (10) selon la revendication 1, dans laquelle l'unité de base (12) comprend un contrepoids réglable (28), et dans laquelle le contrepoids réglable (28), lorsque l'ensemble tête d'aplanissement (16) est déplacé par l'extension ou la rétraction du mécanisme extensible et rétractable (14), est déplacé automatiquement dans une direction opposée au déplacement de l'ensemble tête d'aplanissement (16) pour contrer le poids de l'ensemble tête d'aplanissement (16) lorsqu'il est étendu et rétracté par le biais du mécanisme extensible et rétractable (14). 30 35 40
16. Machine d'aplanissement (10) selon la revendication 15, dans laquelle le contrepoids réglable (28) est déplacé dans la direction opposée au déplacement de l'ensemble tête d'aplanissement (16) d'une quantité proportionnelle à l'extension ou à la rétraction du mécanisme extensible et rétractable (14). 45
17. Machine d'aplanissement (10) selon la revendication 1, dans laquelle le système de commande peut fonctionner en réponse à un contrôleur à distance utilisable par un opérateur distant de la machine d'aplanissement (10). 50
18. Machine d'aplanissement (10) selon la revendication 1, dans laquelle l'organe d'établissement de niveau (18) comprend un élément choisi parmi le groupe constitué par (i) une charrue à rouleaux et (ii)

une charrue à vibrations.

19. Machine d'aplanissement (10) selon la revendication 1, dans laquelle la machine d'aplanissement (10) aplanit du béton non durci placé à l'intérieur d'une charpente pour former un panneau relevable.



FIG. 1



FIG. 2

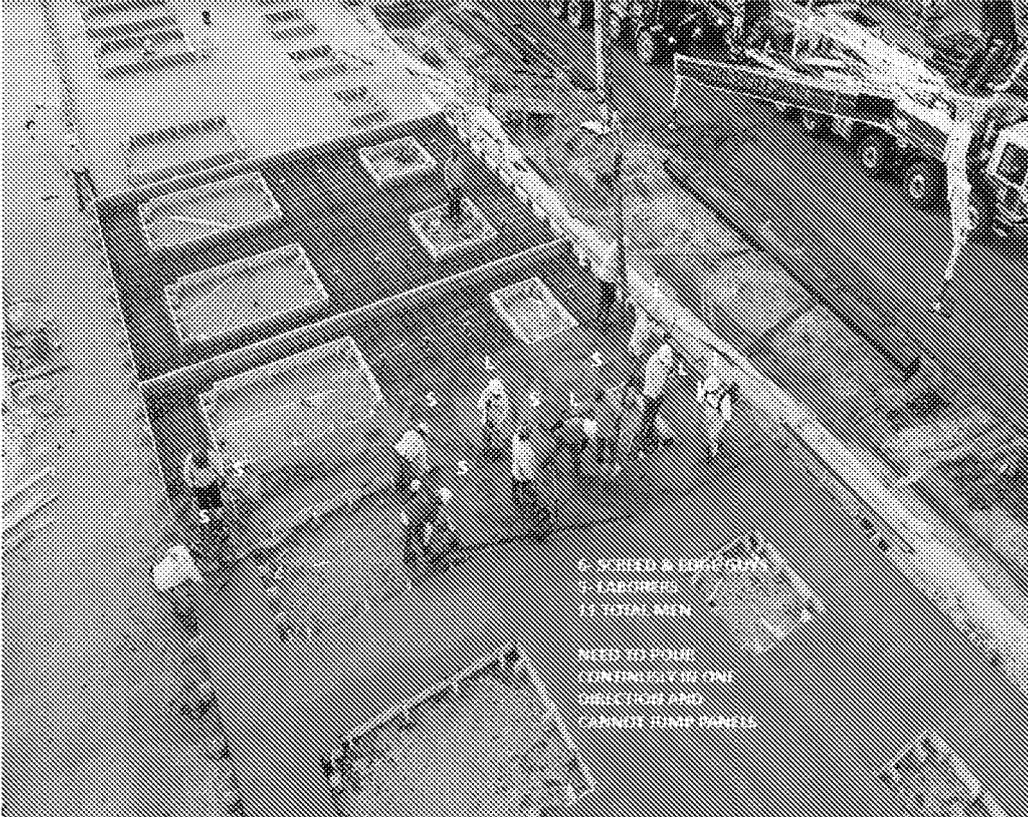


FIG. 3

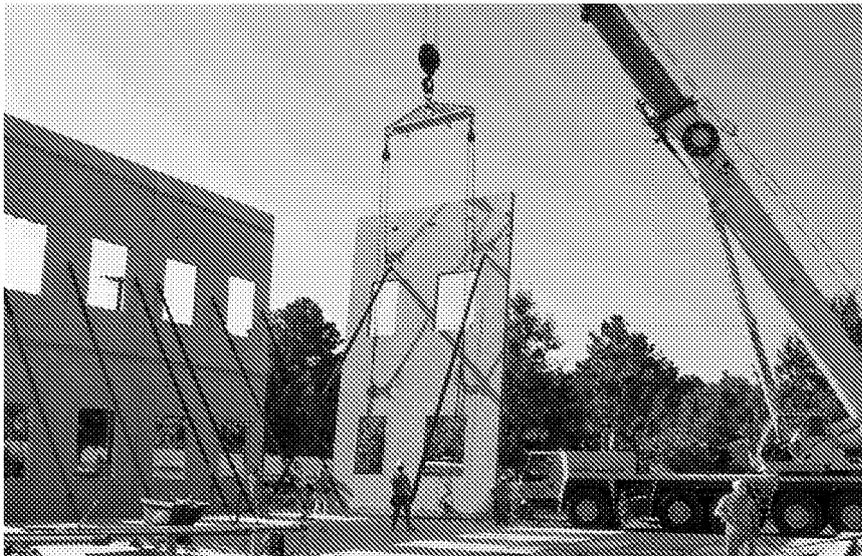


FIG. 4

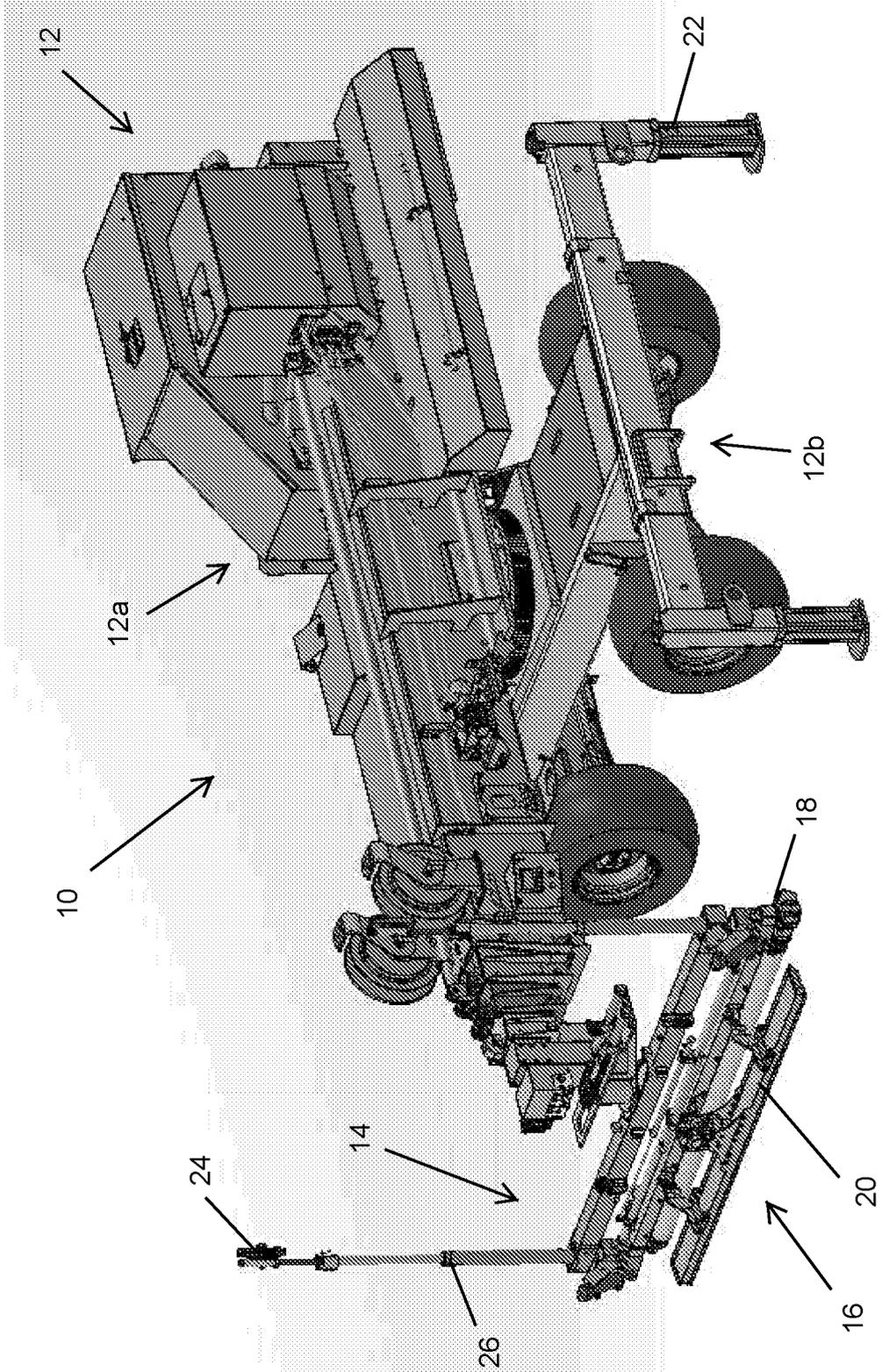


FIG. 5

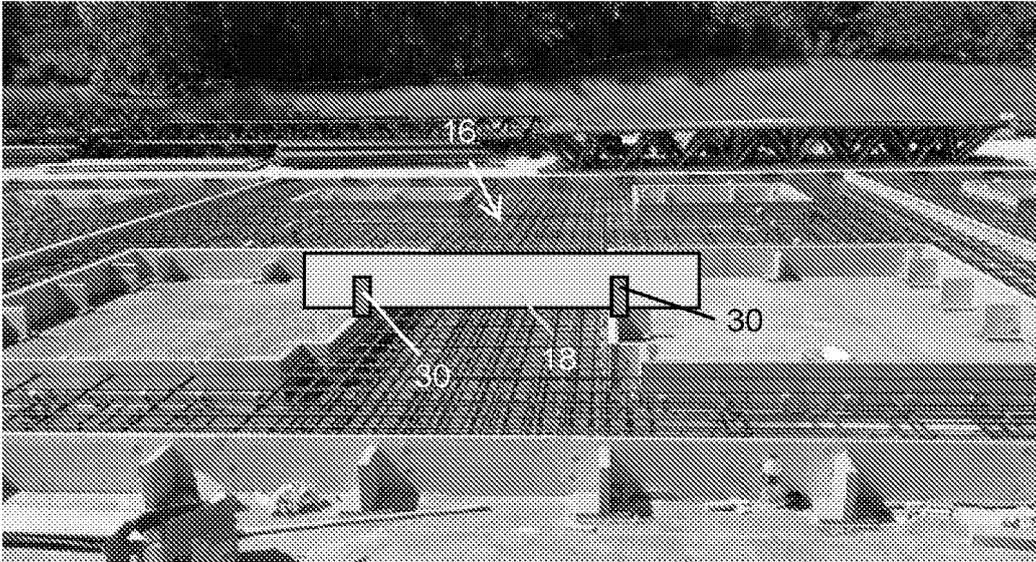


FIG. 6

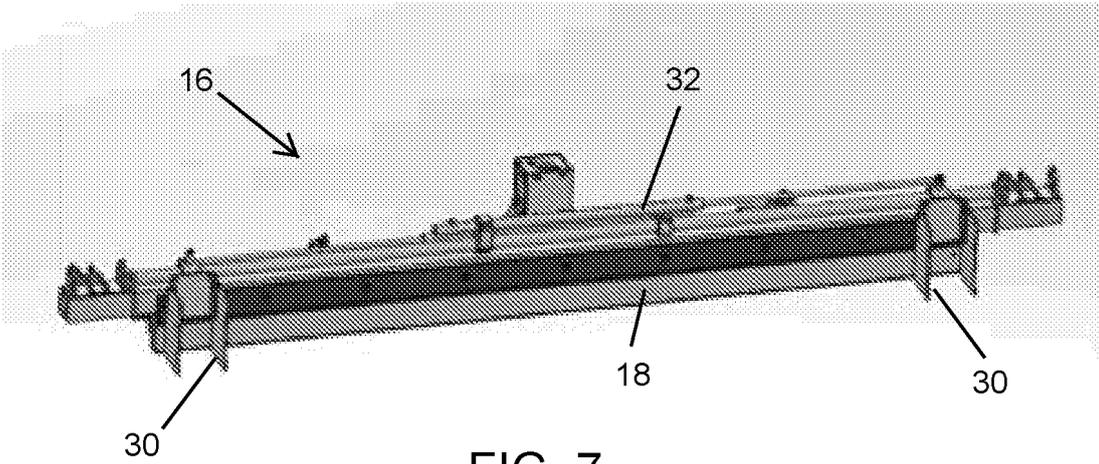


FIG. 7

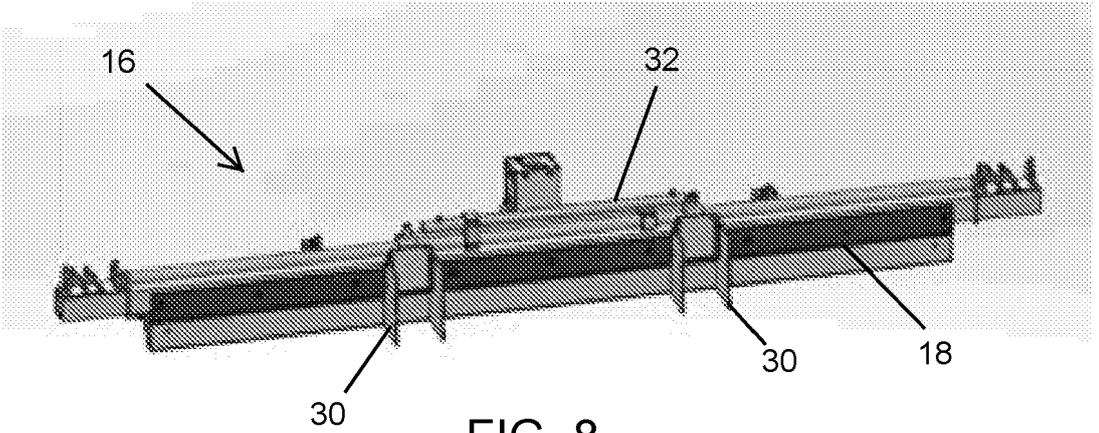


FIG. 8

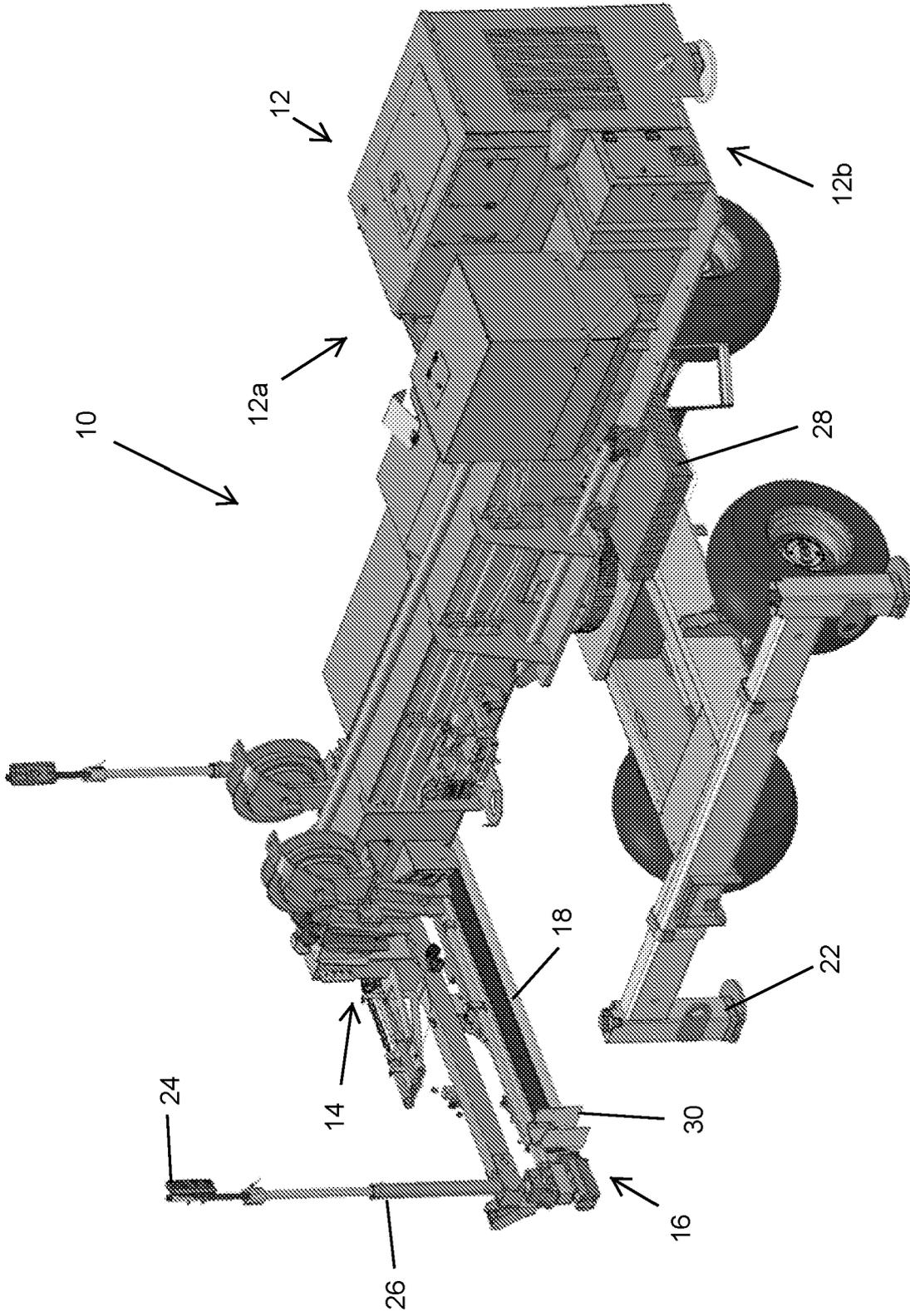


FIG. 9

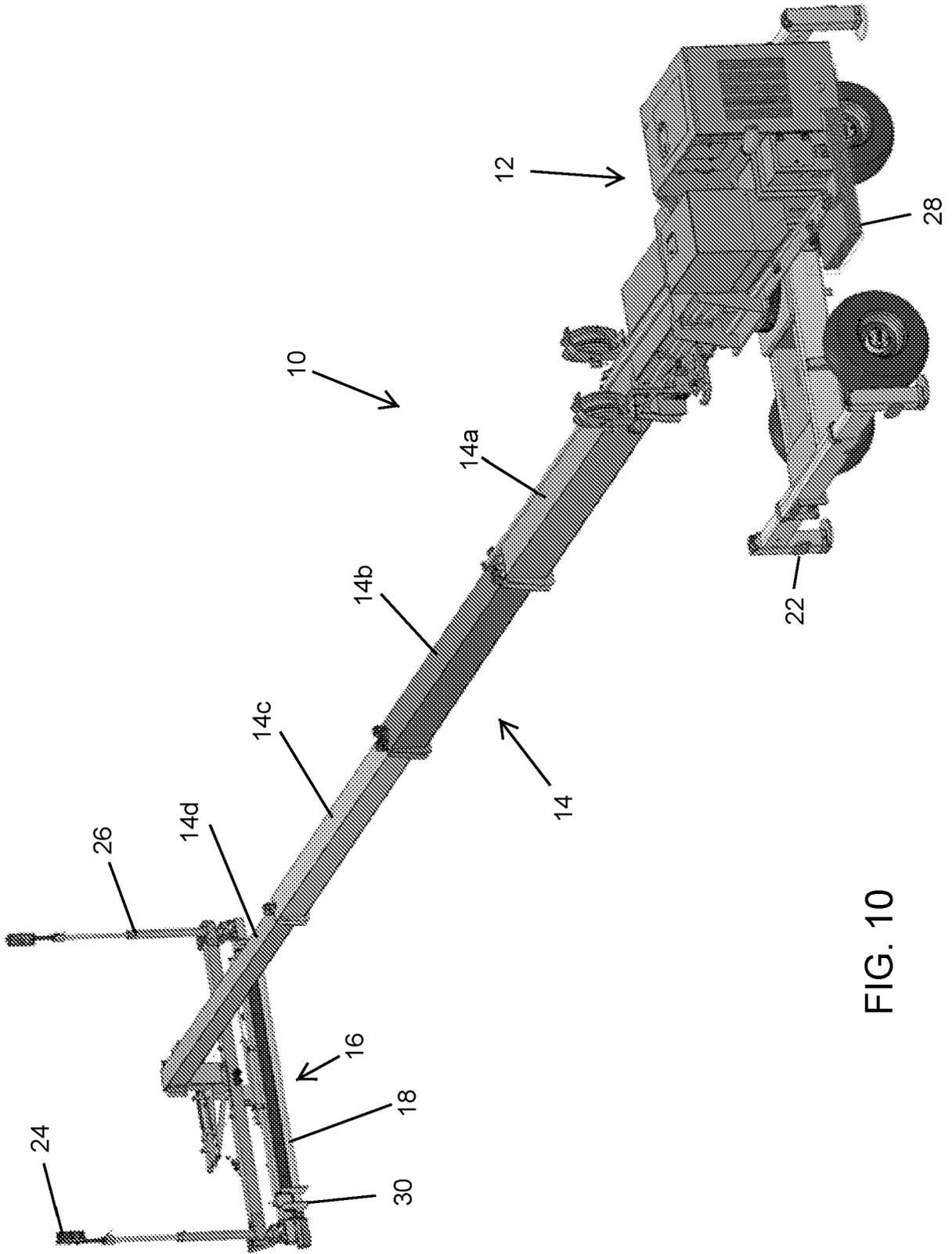


FIG. 10

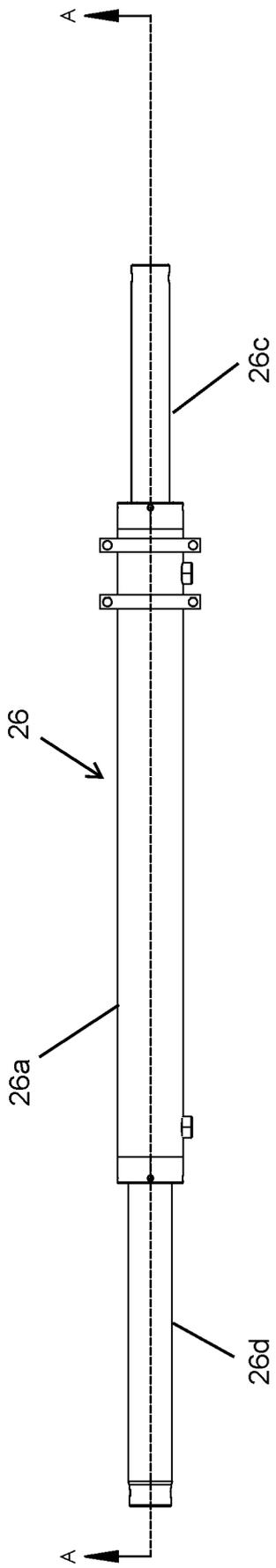


FIG. 11

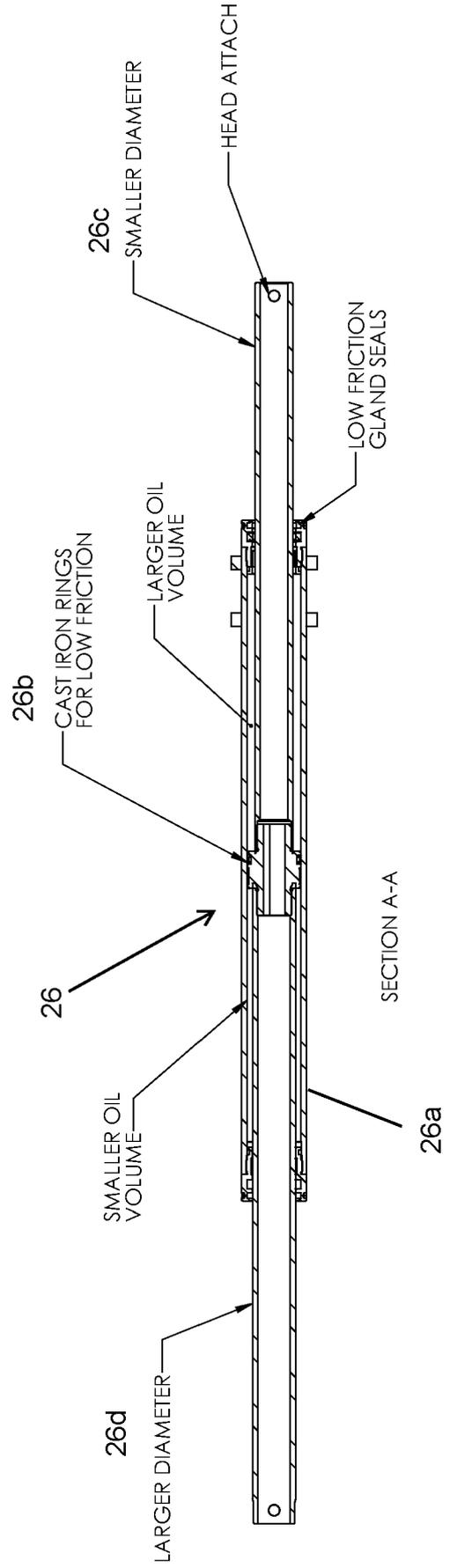


FIG. 11A

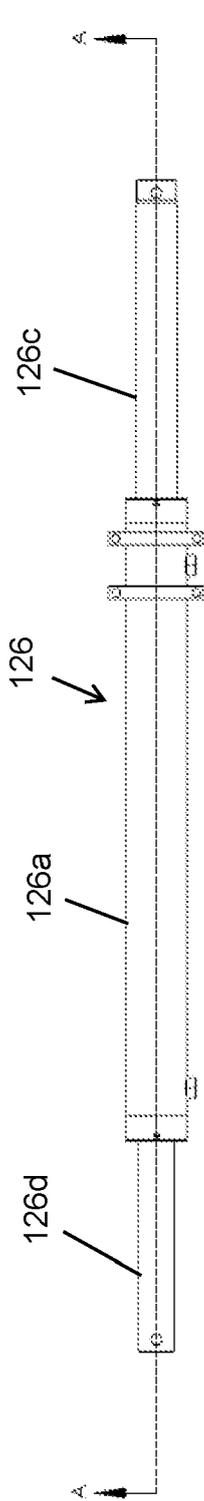


FIG. 12

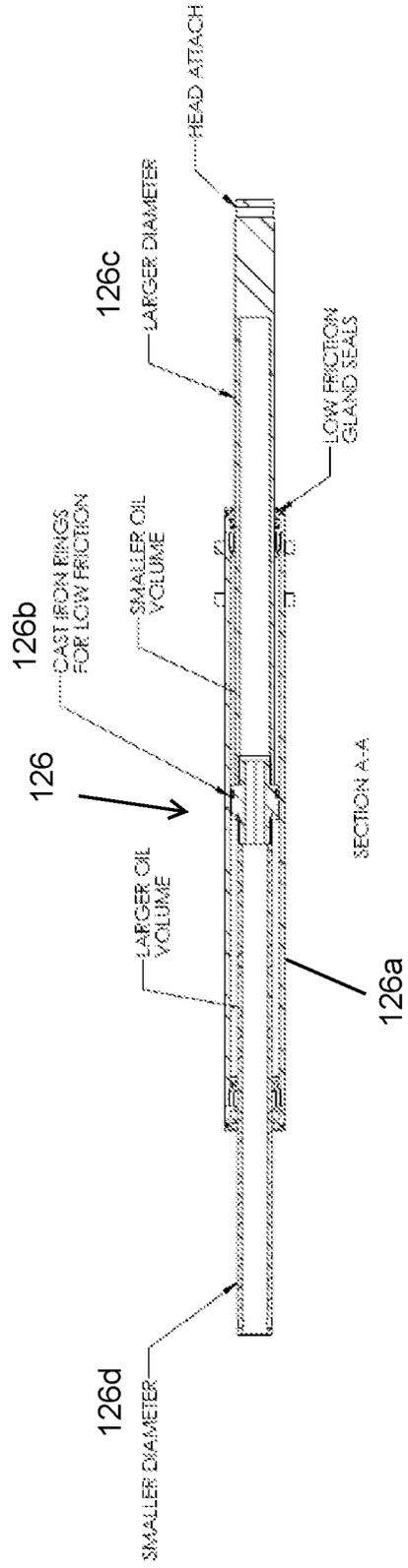


FIG. 12A

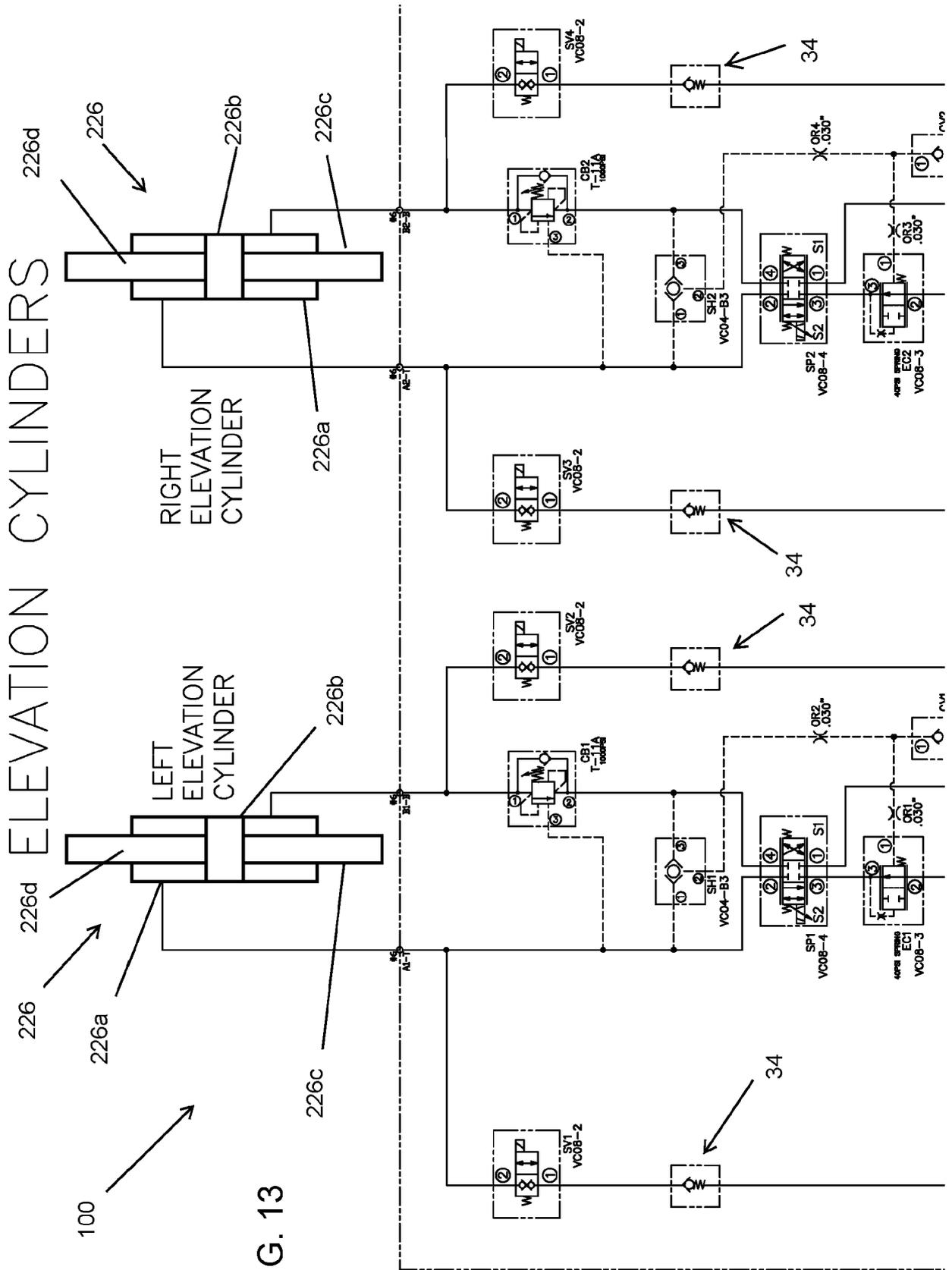


FIG. 13

REFERENCES CITED IN THE DESCRIPTION

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